ATTACHMENT 7:
Annotated Bibliography for *Bridgeoporus nobilissimus*
January 2009

Articles on the biology and ecology of wood-decay fungi that may also apply to, or shed light on, the biology and ecology of Bridgeoporus nobilissimus

Compiled by:
Marty Stein, Botanist, Siuslaw National Forest
Terry Fennel, Botanist, Salem BLM
David Lebo, Botanist, Mt. Hood National Forest

1. Bader, P., S. Jansson and B. G. Jonsson. 1995. Wood-inhabiting fungi and substratum decline in selectively logged boreal spruce forests. Biological Conservation 72:355-362.

- Logging activities in Swedish boreal forests have resulted in a significant loss of woody debris and many organisms associated with dead wood have become increasingly rare.
- Wood-inhabiting fungi were sampled at 11 sites in the Swedish boreal forest representing a gradient of timber harvest intensity. Harvest on these plots had occurred from 1860 to 1925.
- A total of 31 species of wood-inhabiting fungi on 1030 spruce logs were inventoried. 10 of the fungi species have been classified as threatened in Sweden.
- The total number of fungi species and the number of threatened fungi species per site were both significantly negatively correlated with the intensity of harvest.
- Both total fungi species and number of threatened species showed clear and positive correlations with log abundance, log size, and stage of log decay.

2. Berglund, H., M. Edman, and L. Ericson. 2005. Temporal variation of wood fungi diversity in boreal old-growth forest: implications for monitoring. Ecological Applications 15(3), pp. 970–982.

- The study looked at the occurrence of corticoids (Corticiaceae) and polypores (Polyporaceae) over an eight year period and compared species richness and composition at different spatial scales in unexploited boreal old-growth forests.
- Most wood-fungi species occur as fruiting bodies at low frequencies in the boreal old-growth *Picea abies* forests studied. This was true at both substrate and stand levels.
- Data show 90% of all polypore species are likely to be recorded after two consecutive inventories. The assessment of wood-fungi species diversity can therefore be improved by conducting inventories at particular sites in two consecutive years. The sum of two successive inventories is potentially a valid

reference point for subsequent monitoring of wood-fungi species diversity in boreal old-growth forests.

- The lifespan of fruiting bodies of most species was shorter than four years, although fruiting bodies of some species (e.g., *Phellinus* spp.) remained vital throughout the eight years studied. Species with tough, persistent fruiting bodies can be identified for an extended period, however it should be noted that if only dead fruiting bodies are found, the species may already have become locally extinct, and erroneous interpretations about their status may be drawn.

3. Edman, M., N. Kruys and B. G. Jonsson. 2004. Local dispersal sources strongly affect colonization patterns of wood-decaying fungi on experimental logs. Ecological Applications 14:893–901.

- Freshly cut logs of varying sizes were placed in stands with contrasting abundance of natural CWD and subsequently varying pools of wood-inhabiting species. The first six years of colonization by wood fungi show that local abundance and composition of the fungal flora strongly influenced colonization.
- Higher species richness was observed in CWD-rich sites, and several species were more frequent on the experimental logs at CWD-rich sites. The strong within-site effect is interpreted as resulting from high spore deposition from the local species pool. This is supported by spore deposition estimates of *Fomitopsis rosea*, a red-listed species that only occurred on experimental logs at the CWD-rich sites.
- *F. rosea* had a 9–180 times higher spore deposition at the CWD-rich sites compared to the CWD-poor sites.
- Species richness and composition on small logs differed from the greater richness and composition of large logs. The results strongly suggest that restoration efforts would be more efficient if directed toward sites close to CWD-rich sites and that preferably large logs should be created.

4. Edman, M., M. Gustafsson, J. Stenlid, and L. Ericson. 2004. Abundance and viability of fungal spores along a forestry gradient--responses to habitat loss and isolation? Oikos 104:35–42.

- Regional variation in spore deposition and viability was studied for two fungi, *Fomitopsis rosea* and *Phlebia centrifuga*, both confined to old-growth spruce forests in the boreal zone. Seven regions were studied along a north-south transect in which the historical impact from forestry increases and the amount old forests decreases towards the south.
- There was a significant decline in spore deposition towards the south for both species. *F. rosea* deposited an average amount of 111 spores per m−2 in a 24 hour period in the northernmost region compared to less than 1 spore in the four southernmost regions. The corresponding values for *P. centrifuga* were 27 spores m−2 in the north compared to less than 2 spores in the 4 southernmost regions.

- The viability of spores from local populations within each region was measured as germination success on nutrient media. Individual fruiting bodies from large populations in the north generally produced spores with higher germinability than fruiting bodies from geographically isolated populations in the central and southern regions.
- Data suggest that some fungi populations in mid- and south Sweden may suffer from negative genetic effects, possibly associated with fragmentation and loss of habitat. The combination of low spore deposition and low germinability of spores may be a threat to the long-term persistence of *F. rosea* and *P. centrifuga* in southern Sweden.

5. Gjerde, I., M. Sætersdal, J. Rolstad, K. O. Storaunet, H. H, Blom, V. Gundersen, and E. Heegaard. 2005. Productivity-diversity relationships for plants, bryophytes, lichens, and polypore fungi in six northern forest landscapes. Ecography 28:705-720.

- The study investigated the relationship between site productivity and the diversity of vascular plants, bryophytes, lichens, and polypore fungi in forests based on species richness data in 0.25 ha forest plots selected from six study areas spanning a latitudinal distance of 1350 km in Norway.
- A positive relationship between species richness and productivity was found in all taxonomic groups studied. The species richness – productivity curve was steepest at lower productivity range, leveling off when approaching the highest productivity sites.
- Broadly speaking, a ten-fold increase in productivity was accompanied by a doubling of species richness. The strongest relationship was found for polypores at one study area, with an almost ten-fold increase in species richness along the productivity gradient. This study area differed from others because cutting during the last century had been less at high productivity sites than low productivity sites, resulting in particularly skewed distribution of logs in favor of the most productive sites.

6. Hogberg, N.and J. Stenlid. 1999. Population genetics of *Fomitopsis rosea*--a wood decay fungus of the old-growth European taiga. Molecular Ecology 8:703-710.

- The study collected sporocarps (conks) from Sweden, Finland and Russia to test for sterility between populations and to estimate genetic variation (heterozygosity) within populations.
- All spore pairings between different populations produced clamp connections, thus there is no evidence of inter-population sterility in *F. rosea*.
- Overall, heterozygosity was low, with values comparable to vascular plants with a high incidence of self-fertilization. There was also significant genetic differentiation across the sampling area, possibly due to limited gene flow and local non-random mating

- Heterozygosity was lowest in southern Sweden. Possible factors include forest fragmentation resulting in a patchy distribution of the spruce host trees and sterile spores produced by the majority of sporocarps.
- Russian populations with the lowest observed heterozygosity occur in an area of dry, sterile soils and frequent fire interval where pine is dominant. Spruce is restricted to small alluvial ravines, each likely representing a population.

7. Houston, A.P.C., S. Visser, and R.A. Lautenschlager. 1998. Response of microbial processes and fungal community structure to vegetation management in mixed wood forest soils. Canadian Journal of Botany 76:2002-2010.

- The present study was conducted to evaluate if microbial processes and decomposer fungi were sensitive to manual or chemical vegetation management in addition to harvesting and site preparation
- Four treatments were established on three sites that had been clearcut and site-prepared 2 years prior to the initiation of the study:
    1. no treatment on clearcut and site prepped site (control)
    2. glyphosate herbicide (Vision)
    3. triclopyr (Release)
    4. manually operated brushsaws
- The present study demonstrates that further disturbance of the harvested sites as a consequence of manual and chemical vegetation control also has negligible effects on decomposer fungal communities and decomposition or mineralization processes 2 years after disturbance
- Conclusions:
    1. 2 years following glyphosate, triclopyr or brushsaw use in clear-cut and prepared mixed wood forests, basal respiration, microbial biomass and nitrogen mineralization in organic and mineral soil layers were not affected significantly relative to untreated controls.
    2. Fungal community structure….was not altered 2 years after vegetation management was carried out on a clear-cut and prepared forest soil.

8. Jonsell, M. and G. Nordlander. 2002. Insects in polypore fungi as indicator species: a comparison between forest sites differing in amounts and continuity of dead wood. Forest Ecology and Management 157(1-3): 101-118.

- The study looked at insect species living in the fruiting bodies of two common polypore species, *Fomitopsis pinicola* and Fo*mes fomentarius,* in Swedish boreal forest and compared their frequency between forests sites differing in the availability and continuity (long-continuity, short continuity, no-continuity)of dead wood.
- A total of 1746 fruiting bodies were sampled at 25 sites. The samples were then brought back to the lab and the insects reared and identified.

- 25 insect species were reared from *F. pinicola* and 27 from *F. fomentarius*, representing a total of 33,100 specimens.
- Two species were more frequent in fruiting bodies at Long-Continuity (LC) sites than at Short-Continuity (SC) or No-Continuity (NC) sites, and one species was more frequent at LC and SC sites than at NC sites.
- Another three species tended to be less frequent at the NC sites. Furthermore, three species were found only at LC sites, but with only a few occurrences. No species showed any tendency for greater frequency at the more managed sites.

9. Jonsson, B.G., N. Kruys, and T. Ranius. 2005. Ecology of species living on dead wood – Lessons for dead wood management. Silva Fennica 39(2):289–309.

- The authors review a large volume of studies on dead wood dependent species and the dynamics of dead wood and ecological theory to identify challenges of forest management at the landscape level.
- Topics include genetic variation, trophic levels, rarity, dispersal, population establishment, habitat requirements, extinction, continuity, decay rates, and temporal and spatial considerations.
- The problems and challenges are similar in many forest ecosystems. The authors address the necessity to
    1) counteract the current shortage in availability of dead wood,
    2) concentrate planning at the landscape level in order to minimize isolation and reduce edge effects,
    3) create a variety of dead wood types, and
    4) utilize available quantitative analytical tools.

10. Junninen, K. 2007. Conservation of polypore diversity in managed forests of boreal Fennoscandia. Academic Dissertation presented May 5, 2007. University of Joensuu, Joensuu, Finland.

- Patterns of polypore assemblages are described along the gradients of forest succession and naturalness, and the effectiveness of some biodiversity-oriented forestry methods for maintaining the diversity of polypores in managed forests is evaluated. The data include a total of 19,617 records of fungi representing 129 species of polypores and 133 species of corticiaceous fungi.
- For wood-inhabiting fungi, in managed as well as in natural forests, the most species-rich phase of forest succession is the first stage after a major disturbance (wildfire or clear-cutting). The fungal assemblages at the first stage of forest succession are distinctive, particularly in natural forests, compared to the assemblages at later successional stages.
- After the first stage of succession, the level of forest naturalness is more important than the successional stage in determining the diversity of polypores. Particularly threatened species suffer with increasing levels of

management intensity, and in the most intensively managed forests, no threatened species can be found.

- The short-term effects on polypores from logging are more dramatic than the effects of fire. On the time scale of four years, logging changes the species composition of polypore assemblages, increases dominance and increases the overall polypore abundance, but decreases the proportion of red-listed and species designated as biodiversity indicators.
- Fruiting body production of most polypore species seems to be more or less indifferent to the general microclimatic conditions of the habitat The abundance of dead wood appears to be a more important factor in predicting species richness than site microclimatic conditions.

11. Kauserud, H. and T. Schumacher. 2003. Genetic structure of Fennoscandian populations of the threatened wood-decay fungus *Fomitopsis rosea* (Basidiomycota). Mycological Research 107 (2):155–163.

- In this study, five widely separated populations of *F. rosea* in Norway, Sweden and Finland were studied for genetic variation using codominant PCR–RFLP and ASA markers, and dominant ISSR markers. The prime goals were to characterize the genetic structure of populations to infer dispersal capacity and levels of outcrossing and inbreeding in populations. The mating system and mating type richness in two populations were also characterized using in vitro mating.
- The codominant data and the ISSR markers revealed little genetic differentiation among geographic populations, indicating high dispersal capacity and gene flow. The low level of genetic differentiation indicate that Fennoscandian populations of *F. rosea* all belong to a larger population sharing the same gene pool, and are not reproductively isolated.
  - High mating allele richness observed in the two investigated Norwegian populations indicates a high genetic variation and lack of inbreeding.
  - Marked heterozygote deficits and inbreeding due to small population size were generally not observed.

12. Penttila, R. and H. Kotiranta. 1997. Short-term effects of prescribed burning on wood-rotting fungi. Silva Fennica 30(4):399-419.

- Prefire fungal flora (polypores and corticoid fungi) of 284 dead trees, mainly fallen trunks of Norway spruce, was studied in 1991 in an old, spruce-dominated mesic forest in southern Finland. Species diversity of the prefire fungal flora was very high, including a high proportion of locally rare species and 4 threatened polypore species…
- …the whole area was burned. Burning was very efficient and all trees in the forest stand were dead one year after the fire. Also, the ground layer burned almost completely.

1. Fire destroys the mycelia or decreases the inoculum potential of many fungi by consumption of dead woody material and by creation of extreme environmental conditions (additional reference).

- Greatest losses in species numbers occurred in moderately and strongly decayed trees, in coniferous trees and in very strongly burned trees. Fungal flora of non-decayed and slightly decayed trees, deciduous trees and slightly burned trees seemed to have survived the fire quite well and in these groups the species numbers had increased slightly as compared with the prefire community.
- Species favored by fire were mainly ruderal species, which can utilize new, competition-free resources created by fire, and species that have their optima in dry and open places also outside forest-fire areas.
- In the tree trunk the conditions (e.g. moisture) for mycelial growth and fruiting are more constant than in the ground (additional references)..this is probably the most important reason why fruiting seems to be more constant in wood-rotting fungi than in mycorrhizal or litter-decomposing macrofungi.
- In disturbed areas, it is usually the ruderal species that should increase their numbers at the cost of competitive species. Ruderal species are typically characterized by effective dispersal and germination, rapid uptake of nutrients and rapid mycelial extension. They are ephemeral, non-competitive and have a rapid and often total commitment to reproduction (additional references).

13. Penttila, R., J. Siitonen and M. Kuusinen. 2004. Polypore diversity in managed and old-growth boreal *Picea abies* forests in southern Finland. Biological Conservation 117:271–283.

- Polypore communities were compared between mature managed, overmature managed, and old-growth spruce-dominated forests in southern Finland. A total of 85 polypore species, with 6000 records, were found in 16 sample plots.
- Old growth stands had on average 80% more species than mature stands, and 38% more species than overmature managed stands. Variation in polypore species richness was best explained by diversity of dead wood and the number and volume of dead trees.
- Threatened species were practically confined to old-growth forests and to stands in which the amount of dead wood exceeded 20 m3/ha. This figure appears to represent a stand-level threshold value for the amount of dead wood, below which the persistence of threatened species becomes unlikely.
- Results suggest that a significant increase in the amount of dead wood (e.g. by leaving large retention trees and even by killing trees) is needed in managed forests before they become suitable habitats for threatened polypores.

14. Selonen, V., P. Ahlroth, and J.S. Kotiaho. 2005. Anthropogenic disturbance and diversity of species: polypores and polypore-associated beetles in forest, forest edge and clear-cut. Scandinavian Journal of Forest Research, 20(5):49–58.

- This study seeks to determine whether 1) the amount of dead wood varies between forest and clear-cut, and whether or not this variation affects polypore and beetle assemblages and 2) to determine whether the edge of the forest has an effect on the number of polypore and beetle species and individuals compared with the adjacent forest or clearcut.
- There was a clear edge effect on the species richness and on the number of occurrences of polypores. The edge harbored the least number of species and individuals, while both polypore species and occurrences were most abundant in the clear-cut.
- Orientation of the edge had an effect on the distribution of both polypores and beetles. Both groups seem to avoid edges that face towards north. This result suggests that on a small scale, microclimatic factors may play a role in species distribution. South-facing edges are much warmer and snow melts earlier in spring, probably making them a more suitable habitat for both polypores and beetles.

15. Vasiliauskas, R., A. Menkis, R.D. Finlay, and J. Stenlid. 2007. Wood-decay fungi in fine living roots of conifer seedlings. New Phytologist 441-446.

- Mycorrhizal basidiomycetes are known to have multiple, independent evolutionary origins from saprotrophic ancestors. To date, a number of studies have revealed functional resemblance of mycorrhizal fungi to free-living saprotrophs, but information on the ability of saprotrophic fungi to perform as mycorrhizal symbionts is scarce.
- The study investigates the ability of three wood-decay fungi, *Phlebiopsis gigantea*, *Phlebia centrifuga* and *Hypholoma fasciculare*, to colonize fine roots of conifer seedlings.
- For each fungus, mycorrhizal syntheses were attempted with *Picea abies* and *Pinus sylvestris*. After 24 wk, isolation of fungi and direct sequencing of fungal internal transcribed spacer (ITS) rDNA were carried out from healthy-looking surface-sterilized root tips that yielded both pure cultures and ITS sequences of each inoculated strain. Mycelial mantle of *P. gigantea* was frequently formed on root tips of *P. abies*, and microscopical examination has shown the presence of intercellular hyphae inside the roots.
- The results provide evidence of the ability of certain wood-decay fungi to colonize fine roots of tree seedlings.